

INTEGRATED OR ATTACHED SPACE OCCUPYING CEPHALIC RESTRAINT
COLLAR FOR IMPROVED LIFE JACKET PERFORMANCE

This application claims the benefit of and priority to U.S. Application Serial No. 60/254,380, filed December 8, 2000.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to improving the inherently buoyant Life Jacket's ability to roll the flaccid, unconscious victim, from an airway-submerged face down position into an airway protected face up position.

2. Description of the Prior Art

Currently inherently buoyant Life Jackets are sized to fit all adults. Due to their rigidity, the foam personal flotation device ("PFD") that can accommodate a 300 lb. adult is loose on a 100 LB adult. Consequently when a large percentage of adults lose consciousness, and thus muscular tension in the cervical spinal muscles, the head is free to act under the influence of gravity where it falls forward or to the side totally dependent upon PFD positioning. The head represents 14-17 lbs. of ballast that is more than capable of overpowering the PFD's best efforts to roll the victim from face down to face up.

One current example of the consequences of cephalic dominated surface positioning is that in a single commercial boating accident this last year 16 people drowned while wearing Life Jackets. 50% drowned because their PFD failed to turn them from face down to face up while the other 50% drown after they slipped partially out of their Life Jackets. The

variably sized cephalic restraint disclosed herein directly remedies both these deficiencies.

The synergistic application of eccentric ballast and buoyancy in the production of a reliable heads up positioning of the flaccid unconscious victim lost at sea requires that the Life Jacket firmly yet without compression control the positioning of the victim's head and neck. Since the head typically weighs 14-17 pounds when held out of the water, the eccentric ballast of the victim's head draped off to one side exceeds the applied eccentric airway protective buoyancy and ballast by a factor of 7 to 17 fold. As the PFD attempts to roll the unconscious victim from a face down airway submerged position where the head is submerged its ballast impacting PFD performance is minimal out of the water, the impact of the eccentric head opposes the rotation about the axis in ever increasing fashion. Often as the head surfaces its ballast eventually grinds the rescue rotation to a halt just shy of adequate surface positioning.

The ability of the combined set of forces acting upon the unconscious victim, in particular the upward force of eccentric buoyancy and the downward force of eccentric ballast, to produce their optimal angular acceleration depends on where and how the force is applied and upon what resistances develop opposing those rotational forces. Until the present invention, described below, testers to varying degree, through their choice of tests and through their musculature rigidity, assisted the PFD in appearing to pass to the 5 second turning test. The current international standard three stroke turning test, allows the tester to utilize numerous skeletal muscles that result in the tester oscillating about their axis of rotation as they perform the three strokes immediately prior to 'feigning unconsciousness'.

in its absence ends up floating on their side with their airway submerged.

The current invention serves to align and then secure the head and neck in line with the bodies/PFDs axis of rotation. In this position the ballast of the head is divided evenly about the axis of rotation negating its ability to oppose the PFD's forces being applied in the generation of rotational torque.

Once the range of motion of the victim's head is controlled, the PFD with integrated space occupying cephalic restraint means of the present invention, is able to reliably and consistently effect Active Self Rescue. Active Self Rescue is defined as; when the PFD alone, without any assistance from the victim, is able to roll the unconscious victim's face free of the water, within the 5 seconds required by international standards.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a right lateral view demonstrating overlapping components of an adjustably sized cephalo-cervical restraint;

Figure 2 is an anterior-lateral view of a victim floating in an airway submerged side high position despite wearing a PFD with significant eccentric buoyancy and ballast;

Figure 3 is a frontal view of a two part, variably sized, yoke collar PFD with overlapping anterior and posterior cervical arms providing a wide variation in neck sizing;

Figure 4 is anterior view of an integrated fixed eccentric ballasted PFD with incorporated Cephalo-cervical restraint means;

cover everyone larger than a child, it must be large enough to fit the large adult, consequently the small framed male or female has considerable space around their neck. Between the oversized circumference and the connected anterior entrance opening in the front of the vest the flaccid head and neck have access to an excessive range of motion. The outcome of a loose fit is that the ballast of the unconscious victim's head overpowers the traditional PFD's buoyancy and creates multiple airway submerged surface positions.

The disclosed inclusion provides a space occupying, flexible foam mandibular-cervical collar whose length can be adjusted 46, 47 to conform to a wide range of adult anatomy whether they are a 90 LB or a 300 LB individual. This personalization of fit is critical to the self-rescue function of the Life jacket. Restating, if the head and neck are not adequately restrained and located along the axis of rotation FIG.1, the excessive ballast of the head that drops down and or to the side FIG.2 is capable of overriding the turning torque of the Life Jacket. Through the use of an space occupying, adjustable, flexible collar 2, 3 the neck while enclosed is not compressed. The neck orifice in the PFD has now been reduced so that the head cannot pass through and the space from the back of the jaw to the front is occupied with material of sufficient durometer that the head cannot compress or collapse it. In such a design the wearer is comfortable, the airway is without compromise, yet the PFD maintains uncompromised control of the sizable ballast contributed by a head held out of the water. While the overlapping adjustable mandibular cervical collar can be comprised of spun fiber or open cell foam because its displacement is not critical, since in the operative position the wearer's neck is out of the water, a reasonably stiff yet flexible closed cell foam is

preferred as it enhances the net buoyancy in certain positions and sheds water thereby conferring additional thermal protection. The use of variable securing means 46, 47 such as hook and loop fastening members allows the wearer to uniquely adjust both the diameter and height of the mandibular - cervical restraint. With the head of the victim comfortably and securely positioned, the torque needed to roll the wearer from an airway submerged into and airway protected position is significantly reduced, improving wear ability and therefore compliance. The reduction in the amount of net buoyancy, eccentric buoyancy and ballast results in a smaller Life Jacket acquiring an improved capacity for Self Rescue previously unobtainable even in larger PFDs. It is widely accepted that as the size of a PFD is reduced, comfort is increased. Increased comfort converts directly into improved compliance, the real world touchstone for improved Safety Of Life At Sea ("SOLAS").

For PFDs constructed to fit within existing lockers a single piece splint 72 with a solid shelf to support the mandible 71 can be attached by a loose arm 73 through stitching to the neck of the PFD at 74 (Figure 7). Once the cavity 70 is centered over the trachea the retaining means 75 and 77 are securely fastened by use of an adjustable closure means 76. As seen in Figure 8, to facilitate stowage Fig 8 the entire cephalo-mandibular splint stows within the neck opening of the PFD 80 to allow tight packing, an important issue for a vessel storing thousands of PFDs. The compact cephalo-mandibular restraint is loosely attached to the PFD by a fabric hinge 81 and once located that position is secured by flaps 83 and 85 which mount adjustable closure means 84 and 86. Ideally the compact splint has a notch 87 to locate and comfortably accommodate the chin. As seen in Figure 8 the

fabric hinge preferably requires locating the eccentric ballast in the inferior position so as to not affect face plane.

Given the extreme pressures to reduce the bulk associated with the carriage of thousands of PFDs on a single vessel, the horizontally mounted compact cephalo-mandibular splint 90 works well with PFD designs that have oversized lower ventral buoyant means 97 and 98. It also can be loosely attached to the PFD via hinge 91 and after adjusted to the individual is secured by variable closure means 93, 94, 95 and 96. A notch for the chin 99 helps to locate and secure the splint.

The cephalo-cervical restraint collar comprised of a one part restraint 70-76 or two parts 2 and 3 can be used independently to retrofit existing PFDs in the field by attaching the arms via two adjustable strap means to the bilateral cervical portions 67 of the pre-existing PFD by securing means such as by hook and loop fastening members 65, 66 or zippers, snaps, straps etc.

Similarly a very small orally inflatable cephalic restraint attached to an existing PFD can be used to restrain the range of motion of a flaccid victims head and neck.

Complementing the adjustable anterior cephalo-cervical collar 2, is the posterior cervical foam of the PFD, which ideally is carved out, creating a rearward sloping cylindrical depression 4 (Figure 1). This cylindrical depression guides the neck as it drops backward into this sculpted receptacle thereby assisting the wearer in correctly positioning the neck along the axis of rotation 10. Additionally, the central positioning and securing of the head and neck in a solitary central position achieves optimal freeboard by preventing the head

from falling to either side as seen in FIG. 2 from which position the corner of the mouth becomes closer to or submerged by water. The complementary posterior cervical foam splint 4 receives and orients the neck facilitating the correct application of the right 3 and left 2 overlapping anterior mandibular 48 - cervical 52 collars.

Figure 7 shows an alternate embodiment of the cephalo-mandibular splint as a single piece solid foam block 72 built of glued layers or cast in a mold. While providing a solid support surface 71 for the inferior aspect of the mandible the solid walls create a hollow space 70 that envelops the throat protecting the thyroid cartilage and its cyclic movement as well as protecting the neck from any pressure by the collars securing means. The foam can be enveloped in a fabric cover 73 secured to the neck of the PFD 74. The other side of the PFD provides a closure means 76 attached to a flap 75 also secured to the PFD at 74. The single piece Cephalo-mandibular splint, illustrated in a posterior superior view in Figure 7, can be sized to fit within the PFD neck opening. The splint can be loosely attached for variable sized positioning then secured by a separate set of closure means.

Between the posterior cervical portion of the PFD and the ventral arms is a hinge section that serves a dual roll. To be stored in standardized PFD lockers mounted on many vessels the PFD optimally lies flat during storage. Once donned the vest must flex at the neck or it will force the individuals head forward both uncomfortable and out of line with the axis of rotation. The concurrent use of a two part mandibular cervical collar allows the hinge section of the PFD to remain relatively thin, i.e. constructed of only fabric. This allows the eccentric ballast component to be located on the lower portion 54 of the PFD where it does not impact face plane

angle. This fabric hinge also allows the wearer of a PFD that flexes easily and optimally to align the head and neck along the axis of rotation. It is also preferred that the cephalic splint can be worn loose or disconnected until needed. In this way the cephalic restraint PFD acts and feels like a CO2 detonator activated Life Jacket, the wearer remains comfortable and unconfined until the gravity of the situation places a priority on airway protective efficacy over and above wearer comfort, such as when one is preparing to abandon their vessel. Alternatively, with a PFD of solid foam construction Fig. 5 the solid foam is notched 60 to reduce the amount of material on both sides of the neck allowing the posterior portion of the PFD to flex rearward allowing the head to align with the axis of rotation. Additionally the posterior cervical portion of the PFD is sculpted to complement the back of the neck, 64 and the anterior portions 62, 63 are cast to complement the curve of the wearers neck as well as the angle of the axis of rotation 10. It is preferred that at least one or two layers of foam cross the hinge section.

In order to contain costs a manufacturer may prefer to not sew the external fabric of the PFD to the entire perimeter of the over sized base layer of foam as preferred. In such case, through sewing at this hinge 56 ties the foam and the fabric into a structural whole. The structural integrity serves two purposes, primary being the efficient transfer of the force generated by the eccentric buoyancy on one side and the force generated by the eccentric ballast on the other so that these forces summate in generating the strongest torque possible per given force. As testing evolves to become more reflective of the real world events that transpire in a PFDs responsibilities in rescuing an unconscious man overboard, (i.e. as stationary tests are developed that eliminate

tester's unwitting contribution to PFD performance) and as testers begin wearing clothing other than bathing suits which is more reflective of actual conditions confronting them in water PFD rescue, every design element must be optimized if the PFD is to achieve at least satisfactory or sufficient airway protective righting. Secondly, as PFDs age, the fabric is the first to feel the effects of sun, salt, chemicals and use. As the fiber loosens the fabric increases in laxity and any discontinuous elements rotate about each other rather than effectively transfer their energy into rotating the victim. When the fabric and foam are structurally tied together 56 the fabric gains from its connection to foam that is both protected from the elements as well as not constructed from fibers inclined to unravel or loosen.

Additionally disclosed is the attachment means for securing the fixed eccentric ballast within the bodice of the PFD FIG.4. The ballast is securely threaded onto webbing 45 that is bar tacked closed 51. The individual arms of the webbing 42, 43 are then sewn 53 and or glued to the adjacent layers of foam selected for attachment. Lastly the layers of foam are completely glued together. Ideally the remainder of the PFD foam elements are glued when indicated creating a structural integrity within the PFD so that the eccentric buoyant 6 and ballasting forces 5, 41 are acting with optimal efficiency about the same axis of rotation 10.

Also disclosed is an alternate means of controlling a flaccid neck and head, by a dual interlocking PFD, (FIG. 3) that overlaps behind and in front of the victim's neck. An eccentric shaped opening 31 allows the shape of the enlarging opening to remain circular as the diameter increases. The overlapping top pieces 32, 33 slide within a common sleeve 34 so that they are retained in position and the overlap beneath

the chin is reduced by the wearer through tightening the straps 8 that encircle the PFD and compress its buoyancy about the wearers thorax. Dual straps increase both the rigidity of the two part PFD and improve the capacity of the PFD to remain attached as well as in position upon a limp wet victim in a riled sea state. For the individual that has to drop a distance from a vessel into the water or an individual who has to spend any length of time at sea before rescue, a crotch strap 12 (FIG. 1), is an irreplaceable component of any PFD in order to prevent the flaccid victim from slipping down if not out through the bottom of the PFD.

Thus, the present invention provides an integrated or attached (built in or retrofitted) space occupying (fills space beneath the chin) cephalic restraint collar (holds the head in the axis of rotation) for improved life jacket performance. The current invention assists with aligning and securing the head and neck in line with the axis of rotation. In this position the ballast of the head is divided evenly about the axis of rotation negating its ability to oppose effective rotation.

The cephalo-cervical restraint improves the efficacy of all PFD designs elements targeting turning. By guiding the head into the cylindrical notch in the posterior cervical foam behind the victim's head the head is then aligned along the axis of rotation where the heads 14-17 pounds of ballast is symmetrically distributed about that axis. Therefore, whatever eccentric forces are applied in the generation of angular acceleration or torque, do not have to overcome the offsetting effects of the heads ballast acting as a mobile ballast element. Preferably, the collar has soft inner fabric for comfort and warmth.

The inflatable and foam collar embodiments provide mandibular support (anterior superior range of motion) and bracketing (side to side motion). The collar embodiments can be used as ballistics collar PFD, which previously had no turning requirements by UL or USCG. When used as a ballistics collar PFD, especially as an inflatable collar, the cephalic restraint serves to create a new level of turn performance for an unconscious victim wearing 20-30 lbs. of ballistics protection.

The inner layer can be a loose fiber, the next layer a soft conforming foam, the outer layer a stiffer foam such as used in the PFD. Together the two sides interlock allowing sufficient comfort yet setting a firm limit to the head's range of motion. The collar can be further modified to include a mandibular portion that lays along the victim's jaw then seeps under the chin. The cephalo-cervical restraint allows the PFD to be uniquely and perfectly sized, aligns the head for rotation and prevents the victim from slipping out or down within the PFD.

The cervical collar pieces illustrated in the upper left hand corner of Figure 10 are seen to preferably join behind the head. This joint allows flexion upon opening so that the head can easily pass through the PFD's neck opening. The right and left half of the cervical collar form the neck opening which is identified in the upper right hand drawing as preferably being approximately 13 cm by 13 cm. However, the invention is not limited to any specific dimensions and all possible dimensions are considered within the scope of the invention. Since storage is such a premium on cruise liners which often carry two or three sets of PFDs per passenger for 5,000 passengers per cruise, the use of the neck

opening to store the cephalo-mandibular restraint splint allows current lockers to be used without modification.

In detail the mandibular splint can be constructed of layers of closed cell foam creating a convexity that surrounds the larynx allowing support along the entire jaw line without compressing the voice box or airway. Other materials can be used, such as, but not limited to, fibers and open cell foam, and are also considered within the scope of the invention.

Though the invention is primarily discussed with use of foam type PFDs, it should be recognized, that the various embodiments of the present invention can also be used with inflatable type PFDs, and such use is also considered within the scope of the invention. Furthermore, the various restraint devices, though shown in foam configuration, can also be provided in inflatable configurations, and such uses are also considered within the scope of the invention. Thus, an independent inflatable cephalic restraint means can be provided with a self closing self locking collar.

Index of Components

1 Cephalo-mandibular space occupying restraint means (space occupying function of cephalic restraint/mandibular splint)

2 Variable length left overlapping component of cephalo-restraint means

3 Right component of cephalo-cervical restraint

4 Sculpted depression within the posterior cervical foam of PFD receiving the nape of the victim's neck.

5 Right eccentric ballasted illumination / signaling means

6 Left ventral eccentric buoyant means

- 7 Right ventral arm of Yoke Collar style PFD
- 8 PFD attachment strap
- 9 Water entry victim
- 10 Axis of rotation of unconscious victim
- 11 Head held firmly in alignment with axis of rotation
- 12 Crotch strap
- 13 Loose woven means locating specific attachment site for additional ballast
- 14 WARNING symbol advising against attachment of ballast on the PFD's eccentric buoyancy side
- 21 Flaccid neck allows head to roll forward and down while wearing a traditional PFD allowing the nose and mouth to submerge beneath the waterline.
- 31 Variable sized neck opening, can be reduced to specific size of victim donning the PFD.
- 32 Forward component of the posterior cervical adjustable overlapping arms of PFD
- 33 Rear component of the posterior cervical adjustable overlapping arms of PFD
- 34 Retaining means allowing the rear and forward components to slide over one another, adjusting their position with out separating.
- 35 Forward component of anterior cervical adjustable overlapping arms of PFD
- 36 Rear component of anterior cervical adjustable overlapping arms of PFD
- 37 Eccentric bilateral curve of adjustable circumferential cervical opening
- 41 Integrated Fixed eccentric ballast means
- 42 Attachment means for integrated ballast, sewn & glued to inferior foam layer

43 Attachment means for integrated ballast, sewn & glued to superior foam layer

44 Notch in foam layer enclosing fixed eccentric ballast

45 Webbing for securing internal or external ballast to foam and fabric of the PFD

46 Variable position secure attachment means for left component of cephalic restraint

47 Variable position secure attachment means for right component of cephalic restraint

48 Mandibular portion of left cephalic restraint

49 ~~Mandibular ? cervical notch in left arm of cephalic restraint~~

50 Hinge means for mounting external eccentric ballast component, accessible outside fabric shell for reversibly attaching ballast or signaling/illumination device.

51 Bar tack isolating internal from external ballast elements

52 Cervical portion of left cephalic restraint

53 Stitching attaching ballast retaining means to foam layer

54 Independent external attachment means

55 Mobile secondary external ballast attachment hinge means as a continuation of the fixed internal ballast attachment means

56 Through sew line at PFD cervical hinge zone structurally connecting fabric and foam

60 Bilateral mid-cervical hinge cast into the solid foam during construction.

61 Posterior cervical portion of PFD

62 Superior aspect of overlapping arm 35 cylindrically sculpted and angled to position neck along axis.

63 Superior aspect of overlapping arm 36 cylindrically sculpted and angled to position neck along axis.

64 Posterior portion of PFD cervical foam cylindrically sculpted and angled to complement back of the neck along the axis of rotation

70 Hollowed cavity created by solid cephalo-mandibular splint

71 Mandibular support surface

72 Solid cephalo-mandibular splint

73 Loose arm of fabric shell used to attach solid splint to body of PFD

74 Attachment site between cephalo-mandibular splint and closure means to body of PFD

75 Overlapping flap attached on opposite side

76 Variable closure means for adjusting size of neck opening and securing splint to PFD wearer.

77 Overlapping left closure means with outward facing variable attachment means Velcro TM

80 Compact cephalo-mandibular restraint stowed within PFD neck opening

81 Loose fabric attachment means for compact splint allowing adjustable positioning

83 Left fabric flap for securing compact splint

84 Variable closure means to adjusting position of compact splint to wearer anatomy

85 Right fabric securing means for compact splint

86 Variable attachment means for adjusting size of neck opening of PFD to individual anatomy.

87 Cervical notch in compact splint to locate and accommodate wearer's chin

88 Fabric hinge area of PFD free of foam

90 Horizontally mounted cephalo-mandibular restraint stowed compactly against ventral arms of PFD

91 Right loose hinge to accommodate opening arms of PFD during donning as well as final customized positioning of cephalo-mandibular restraint.

92 Left loose hinge to accommodate opening arms of PFD during donning as well as final customized positioning of cephalo-mandibular restraint.

93 Left variable closure means for securing splint in exact position to accommodate individual anatomy

94 Left complementary variable closure means for securing splint in exact position to accommodate individual anatomy

95 Right variable closure means for securing splint in exact position to accommodate individual anatomy

96 Right complementary variable closure means for securing splint in exact position to accommodate individual anatomy

97 Right lower volume ventral buoyant means

98 Left higher volume/eccentric buoyant means

99 Notch in horizontally mounted cephalo-mandibular restraint to locate and stabilize the wearer's chin

Some of the features and characteristics of the present invention include, but are not limited to, the following:

1 A space occupying cephalic restraint means integrated into PFD.

2 An adjustably sized PFD capable of being individually tailored to a wide range of different neck sizes, quickly, while in the field.

3 Adjustably sized mandibular-cervical space occupying collar built into PFD.

4 One, two or more over lapping collars that in total depth fills the posterior to anterior space beneath the mandible supporting the jaw from falling forward or to the side.

5 Solid foam mandibular splint sculpted to provide protected space to allow unobstructed breathing and swallowing

6 Variable closure means for securing adjustably sized cephalic restraint.

7 Fiber filled cephalic restraint collar.

8 Open cell foam filled cephalic restraint collar.

9 Closed cell foam filled cephalic restraint collar.

10 Distinct mandibular and cervical portions of cephalic restraint.

11 Dual layer construction mandibulo-cervical collar, inner layer soft moldable padding and outer more rigid foam structure.

12 Stretchable element in covering allowing cephalic restraint to be adjustably tensioned.

13 The anterior face of the posterior PFD foam neck portion, cylindrically sculpted to receive, align and cradle the wearer's neck.

14 Adjustable overlapping posterior foam portion of PFD.

15 Retaining means to keep overlapping posterior portions aligned and contiguous.

16 Adjustable overlapping anterior portion of PFD.

17 Combined adjustable and overlapping posterior and anterior portions of PFD constructed of solid foam or foam layers.

18 Internal ballast element housed in notch within the PFD foam body.

19 Internal ballast secured by retaining means secured to one or more foam layers.

20 External ballast attachment means secured to one or more foam layers.

21 External ballast attachment means constructed from a continuation of the internal ballast attachment means.

22 Two part cephalic restraint means that can be attached in field to existing PFDs to retrofit with reliable surface airway protection.

23 One or more part inflatable cephalic restraint means built in during construction to the inherently buoyant PFD, creating a hybrid PFD with single surface position.

24 Independent inflatable cephalic restraint means that can be attached in the field to existing PFDs.

25 Loose woven patch identifying the specific site for attachment of any device to the PFD to augment turning torque.

26 International WARNING symbol informing wearer to not attach light/ballast on the side designed and constructed to be the source of the eccentric buoyant driving force.

27 Notched hinge section built into the mold for a solid foam PFD.

28 Complementary sculpted cylindrical depressions built into the posterior and anterior cervical sections of the mold for casting of a solid foam PFD.

29 Compact Cephalo mandibular splint sized to stow within neck opening of PFD.

30 In PFDs with complete separation between posterior cervical collar and ventral arms internal or external ballast is ideally attached to the right ventral arm.

31 Horizontally mounted adjustably sized compact cephalo-mandibular restraint stows flush against the ventral buoyant means of the PFD.

32 Horizontally mounted adjustably sized compact cephalo-mandibular restraint with notch to locate and accommodate the wearer's chin.

The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.